

6. EDUCATION AND OUTREACH

6.1 Introduction

NASA's founding legislation directs the Agency to expand human knowledge of Earth and space phenomena and to preserve the role of the United States as a leader in aeronautics, space science, and technology. Throughout the 1990s, however, undergraduate and graduate enrollment and the number of doctorates awarded in science and engineering declined by more than 15%. This trend, along with an aging workforce, places an increasing burden on NASA to maintain its level of achievement in science and technology.

The Laboratory's parent organization, The Earth Sciences Division (Code 610), has established a Committee for Education and Public Outreach, which is charged with coordinating these activities across the Division. Several Laboratory members are also on the ESD committee. Scott Braun, Goran Halusa, Paul Newman, and Lorraine Remer, are all working with David Herring, Program Manager for Education and Outreach, to achieve the Committee's objectives. More information may be found at <http://esdepo.gsfc.nasa.gov/index.php>.

6.2 Education

Interaction with Howard University and Other Historically Black Colleges and Universities (HBCUs)

Partnerships with Howard University:

A part of NASA's mission has been to initiate broad-based aerospace research capability by establishing research centers at the Nation's HBCUs. The Center for the Study of Terrestrial and Extraterrestrial Atmospheres (CSTEA) was established in 1992 at Howard University (HU) in Washington, D.C., as a part of this initiative. It has been a goal of the Laboratory and the Earth Sciences Division to partner with CSTEA to establish at Howard University (HU) a self-supporting facility for the study of terrestrial and extraterrestrial atmospheres, with special emphasis on recruiting and training underrepresented minorities for careers in Earth and space science.

The Laboratory works closely with HU faculty in support of the Howard University Program in Atmospheric Sciences (HUPAS). HUPAS is the first M.S.- and Ph.D.-granting program in atmospheric sciences at an HBCU and the first interdisciplinary academic program at HU. Scientists from our Laboratory contribute to the HUPAS program as lecturers, advisors to students, and adjunct professors who teach courses. A number of HU students have earned M.S. and Ph.D. degrees in atmospheric sciences.

Participation with Howard University on the Beltsville Campus Research Site:

Howard University has for several years been in the process of building a multi-instrument atmospheric research facility at their campus in Beltsville, Maryland. This research facility is part of the NOAA-Howard University Center for Atmospheric Science (NCAS). David Whiteman, Belay Demoz (both Code 613.1), and others from GSFC are assisting in mentoring students and advising with instrument acquisition for the site. One of the main instruments at the site is a world-class Raman lidar built with heavy involvement from Code 613.1.

During the summer of 2006, students from Howard University participated in the WAVES field campaign at the Beltsville site from July 7 to August 10 (see Section 4.2.10).

The field campaign was intended to provide quality measurements of water vapor and ozone for comparison with Aura satellite retrievals and to quantify the air quality. In addition to the Howard University Raman Lidar, the operations included intensive observations by multiple radiosonde/ ozonesonde sensors and other lidar systems during overpasses of the Aura satellite. Continuous measurements were also taken by a 31m instrumented

tower, various broadband and spectral radiometers, microwave radiometer, Doppler C-band radar, Maryland Department of Environment instrumentation, wind profiler, sun photometer, and GPS system. Some of the instruments are pictured in Figure 6.1.

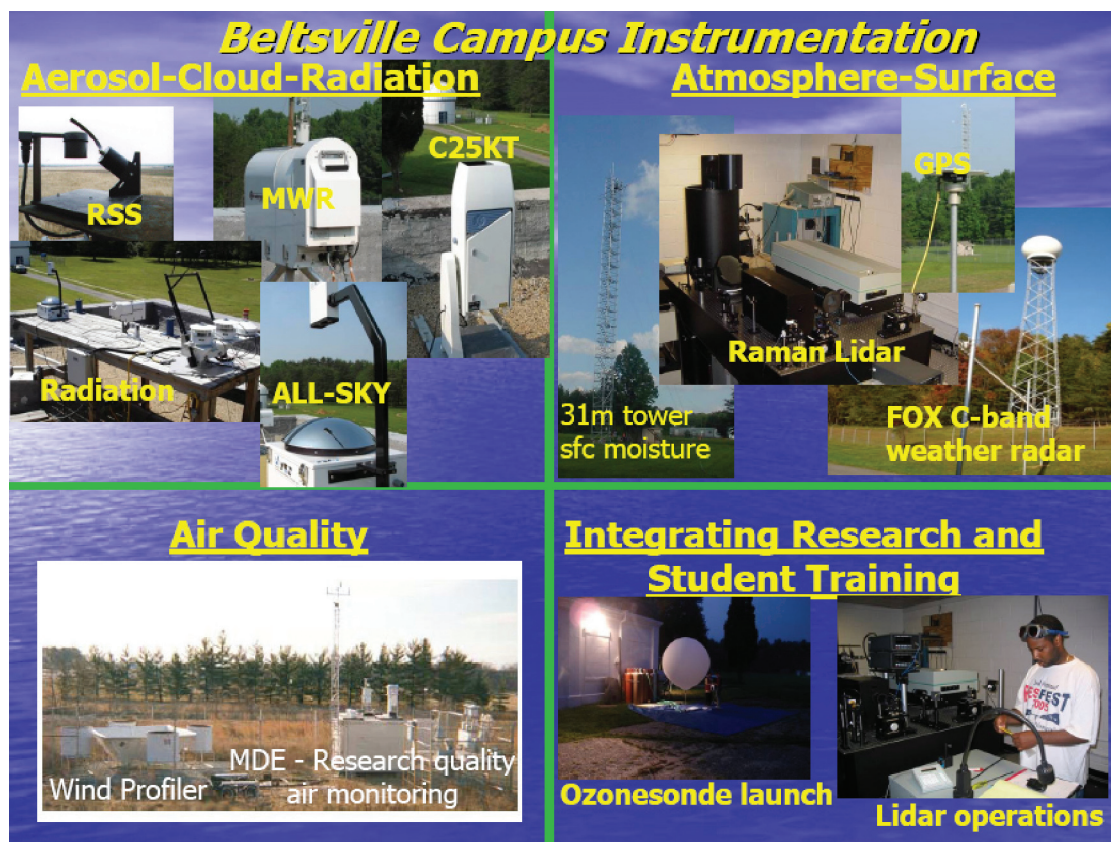


Figure 6.1. Overview of some of the instrumentation used in the WAVES field campaign.

HU students participated in several aspects of the measurement program. Student theses using WAVES measurements are shown in the following table.

Table 6.1 Howard University Students Participating in the WAVES Campaign

Student	Topic	Instrument
Rasheen Connell	Cirrus Cloud Measurements	HURL
Fonya Nzeffe	Aerosol Indirect Effect	Microwave Radiometer
Miliaritiana Robjohn	Modeled vs Observed Fluxes	Instrumented Tower
Segayle Walford	Mesoscale Convective Studies	MDE Wind Profiler

6.3 Summer Programs

6.3.1 The Summer Institute in Atmospheric, Hydrospheric, and Terrestrial Sciences

The Summer Institute in Atmospheric, Hydrospheric, and Terrestrial Sciences was held from June 12 to August 18, 2006. The Institute is organized by Per Gloersen (Code 614.1) and is hosted by the Earth Sciences Division (Code 610). It is designed to introduce undergraduate students majoring in all areas of the physical sciences to research opportunities in these areas. After a one-week series of introductory lectures, the students select from a list of research topics and are mentored by a Goddard scientist for a period of nine weeks. At the conclusion of this period, the students give a presentation of their results. Laboratory scientists participating in the institute, students, and research topics are shown in Table 6.2.

Table 6.2. Laboratory Scientists Mentoring Students in the 2006 Summer Institute

Mentor/Code	Student/University	Topic
Eric Smith, 613.1	Amy Harless, UNC	Role of Gulf of Mexico and Caribbean Sea Hurricanes on Regional Water Budget
Charles Gatebe, 613.2	Daniel Kaufman, Univ. of MD	Cloud Absorption Radiometer (CAR) Web Input and Visualization
Guoyong Wen, 613.2	Julie Nguyen, Grove City College and Brendan Hermalyn, Fairfield Univ	Radiative Non-Equilibrium at the Lunar Surface
Lorrain Remer and Richard Kleidman, 613.2 Santiago Gasso, (613.2, UMBC)	Jamie Matusiak, Valparaiso Univ. Daniel Eipper, Millersville Univ.	Air Pollution in Selected Cities of Sub-Saharan Africa Exploring the Effects of Aerosols on Cloud's Precipitation and Brightness Properties



Figure 6.2. Participants in the 2006 Summer Institute. Per Gloersen is at the left.

6.3.2 Research & Discover: Summer Internship Program in Earth Sciences

Research & Discover is a summer internship program jointly sponsored by the University of New Hampshire (UNH) and GSFC. It is available to students who have completed their junior year of college. Participants receive a stipend, as well as room and board. Following the first summer internship, participants are encouraged to apply for a second summer internship held at the NASA Goddard Space Flight Center. Following this internship, participants will be eligible to receive a two-year fellowship for graduate study at UNH. During summer 2006, the following Laboratory scientists mentored UNH students in their research projects.

Table 6.3. Laboratory Scientists Mentoring Students in the 2006 Research & Discover Program

Mentor/Code	Student/University	Topic
David Whiteman, 613.1	Cassie Stearns, Smith College	EOS-Aura MLS Validation Using Radiosonde Profiles During the WAVES Campaign
Robert Cahalan, Alexander Marshak, 613.2	Brian Cook, U. C. Berkeley	Radiative Transfer Simulations for Clouds Analyzing 3D and 1D Approaches
Ken Pickering, 613.3	Jeremy Ott, Northland College	Convective Transport of Trace Gases and Lightning NO Production in Brazilian Thunderstorms
Susan Strahan, (613.3, SSAI) and Anne Douglass, 613.3	Andrea Crosby, Duke Univ.	Investigation of Cross-Tropopause Mixing in the Subtropics

6.3.3 Goddard Earth Sciences and Technology (GEST) Center Graduate Student Summer Program: GEST-GSSP

NASA Goddard Space Flight Center's Earth Sciences Division, in collaboration with the Goddard Earth Sciences and Technology (GEST) Center of the University of Maryland Baltimore County, offers a limited number of graduate student research opportunities through its Graduate Student Summer Program (GSSP). This prestigious program is in its seventh year and is designed to stimulate interest in interdisciplinary Earth sciences studies by enabling selected students to carry out an intensive research project at GSFC's Earth Sciences Division, which can be applied to the student's graduate thesis.

Positions are available to students interested in any Earth sciences field conducive to the research of NASA GSFC's Earth Sciences Division. Each student is teamed with a NASA Goddard scientist mentor with parallel scientific interests. NASA mentors can be drawn from any of the participating Earth Sciences Laboratories which include: the Laboratory for Atmospheres, the Laboratory for Hydrospheric and Biospheric Sciences, the Global Modeling & Assimilation Office, the Global Change Data Center, and the Software Integration and Visualization Office. During the summer program, there is a lecture series aimed at current popular Earth sciences topics. At the conclusion of the program, students produce final oral and written reports on their summer research activities.

During the summer of 2006, Laboratory personnel acted as mentors for four GEST students. Mentors, students, and their research topics are given in Table 6.4.

Table 6.4. Laboratory Scientists Mentoring Students in the 2006 GEST-GSSP Program

Mentor/Code	Student/University	Topic
Oreste Reale, 613	Marangelly Fuentes, Howard Univ.	Barotropic Instability of the African Easterly Jet.
David O'C Starr, 613.1	Tamara Singleton, UMCP	Investigating Gravity Wave Effects on Cirrus Clouds using a One Dimensional Cirrus Cloud.
Mian Chin, 613.3	Mariya (Shcherbyna) Petrenko, Purdue Univ.	Estimating Carbonaceous Aerosol Emissions from Forest Fires in North American Boreal Forests in July 2004.
Joanna Joiner, 613.3	Partha Sarathi Bhat-tacharjee, George Mason University	Comparisons of Carbon Monoxide Measurements using Aircraft and Model Data.

6.3.4 GSFC High School Internship Program (HIP)

HIP is a research intensive program that allows interns to explore "real-time" applications of Science, Technology, Engineering, and Mathematics (STEM) disciplines. By the end of the summer, interns complete eight weeks of research on a project related to NASA's goals and deliver an oral technical presentation, sharing the results of their research with NASA management, scientists, and fellow interns.

Each HIP student is assigned a NASA scientist or engineer as a mentor and assists the mentor with his or her current project. The interns conduct research and use data for the projects, and the mentors guide the students and help them learn as much as possible from their experience at NASA Goddard.

This year's eight-week program ran from June 26 to August 18. Two Laboratory members mentored students in this program.

George Huffman (Code 613.1, SSAI) mentored Jeremy Lehmann in a project titled, “Quality Control of the ATLAS II Precipitation Gauge Data.”

Prasan Kundu (Code 613.2, UMBC) mentored Mael Flament in a project titled, “Multifractal Properties of Time-averaged Rainfall Data.”

6.3.5 AMS Fellowship Winners’ Visit

On July 12, 2006 the Earth Sciences Division hosted a visit to GSFC by a group of AMS Fellowship Winners. The visit was organized by the Laboratory for Atmospheres and consisted of a morning seminar and an afternoon tour of the clean room and other facilities in Building 29. The AMS Fellowship Program, established in 1991, has awarded over 200 fellowships to students entering their first year of graduate study in the atmospheric or related oceanic or hydrologic sciences, with the total dollars awarded reaching nearly \$3.5 million. The program is designed to attract promising young scientists to the AMS-related sciences and provide adequate funding for their first year, allowing the recipients to focus solely on their studies. The AMS is joined by industry leaders and Federal agencies in sponsoring the fellowships, which carry a \$22,000 stipend. NASA sponsored two of the seven visiting students’ 2006 fellowships. The students, their areas of interest, and universities are listed in Table 6.5.

Table 6.5. 2006 AMS Fellowship Winners Visiting GSFC

Student	University	Research Interest
Andrew Hamm*	Univ. of Oklahoma	Use of Statistics in Atmospheric Science
Rebecca Adams	Colorado State Univ.	Meteorology
Danielle Manning	Florida State Univ.	Hurricane Classification
Matthew Van Den Brocke	Univ. of Oklahoma	Severe Storms
Maura Hahnenberger*	Univ. of Utah	Mountain Meteorology
Daniel Philip Lane	MIT – Woods Hole	Interaction between Tropical Cyclones and Climate
Stephanie Zick	Penn State Univ.	Tropical Cyclone Development

* Indicates NASA ESE sponsored fellowship

During the morning seminar, presentations were given by scientists from the Laboratory for Atmospheres (Code 613), the Hydrospheric and Biospheric Sciences Laboratory (Code 614), and the Global Modeling and Assimilation Office (GMAO, Code 610.1). The agenda consisted of the following:

Franco Einaudi, Director, Earth Sciences Division and President of the AMS

Welcome and opening remarks

Steven Pawson, Global Modeling and Assimilation Office (Code 610.1);

“Modeling the Interactions between Climate and Ozone: Successes and Challenges.”

Jeff Morisette, Terrestrial Information Systems Branch, (Code 614.5)

“Evasive Species Forecast Systems.”

Scott Braun, Mesoscale Atmospheric Processes Branch (Code 613.1)

“Overview of Hurricane Research at Goddard.”

Rich Stolarski, Atmospheric Chemistry and Dynamics Branch, (Code 613.3)

“Interactions between Atmospheric Chemistry and Climate.”

Matt Deland, Atmospheric Chemistry and Dynamics Branch, (Code 613.3)
“Current Status of Satellite PMC Observations.”



Figure 6.3. Franco Einaudi, Director of the Earth Sciences Division and President of the AMS addresses the AMS fellowship winners at the beginning of their visit to GSFC.

During the afternoon the AMS students toured facilities at Building 29, guided by Barbara Lambert, flight hardware photographer with SGT Corp.



Figure 6.4. Barbara Lambert (left) and AMS Fellowship Winners tour the Building 29 centrifuge facility.

The final stop on the Building 29 tour was at a mockup of a shuttle control panel. Here Barbara demonstrated the use of gloves used by astronauts during spacewalks to change panel components, Figure 6.5. Students were invited to try changing various components while wearing these gloves.



Figure 6.5. Barbara Lambert demonstrates the use of astronauts' gloves using a mockup of a shuttle control panel on the second floor of Building 29.

6.4 University Education

Laboratory members are active in supporting university education through teaching courses and advising graduate students. Table 6.6 lists instructors and courses taught.

Table 6.6. Courses Taught in 2006

University	Course	Instructor, Code
UMBC	Physics 721, Atmospheric Radiation	Lazaros Oreopoulos, 613.2
George Mason Univ.	Thermodynamics	Yogesh Sud, 613.2
UMBC	Physics 602, Statistical Mechanics	Prasun Kundu, 613.2
Johns Hopkins Univ.	Physics 615.415.31, Statistical Mechanics and Thermodynamics	Prasun Kundu, 613.2

The following, Table, 6.7, lists Laboratory members serving as graduate student advisors and/or on student Ph.D. committees. Committee members are indicated by an asterisk after the member's name/code. The actual or anticipated date of the student's dissertation defense, if available, is shown after the student name.

Table 6.7. Graduate Student Advising by Laboratory for Atmospheres Members

Member/Code	Student	Degree	Institution	Thesis Topic or Area
Richard Stewart, 613*	Natasha Green May 2006	Ph.D.	Howard Univ.	Examination of Particulate Matter and Heavy Metals and their Effects in At-Risk Wards in Washington, D.C.
Richard Stewart, 613* Belay Demoz, 613.1*	Lizette Roldan May 2006	Ph.D.	Howard Univ.	Characterization of Microphysical Properties of Saharan Dust Aerosols during Trans-Atlantic Transport.
David Starr, 613.1	Tamara Singleton	Ph.D.	UMCP	Influence of Gravity Waves on Cirrus Clouds.
Wei-Kuo Tao, 613.1*	Toshihisa Matsui November 2006	Ph.D.	Colorado State Univ.	Aerosol Effects on Cloud-Precipitation and Land-Surface Processes.
Wei-Kuo Tao, 613.1*	Jiwen Fan August 2007	Ph.D.	Texas A&M Univ.	Cloud-Chemistry-Aerosol Interactions.
Wei-Kuo Tao, 613.1*	Thomas L. O'Halloran Summer 2007	Ph.D.	Univ. of Virginia	Cloud-Land-Vegetation Interactions.
Steven Platnick, 613.2*	Joonsuk Lee Spring 2007	Ph.D.	Texas A&M Univ.	Not Defined.
Steven Platnick, 613.2*	Brent Maddox	Ph.D.	Univ. of Wisconsin, Madison	Not Defined.
Charles Gatebe, 613.2	Juliao J. Cumbane	Ph.D.	Univ. of Johannesburg, South Africa	Investigations of Clean Air Slots over Southern Africa from Multian-gular Measurements.
Charles Gatebe, 613.2 External Examiner	Patience Ngwaze	Ph.D.	Univ. of Johannesburg, South Africa	Physical and Chemical Properties of Aerosol Particles in the Troposphere: An Approach from Microscopy Methods.
Alexander Marshak, 613.2*	Dong Huang August 2006	Ph.D.	Boston Univ.	Not Defined.
Prasun Kundu, 613.2	Ravi Siddani	Ph.D.	UMBC	Space-time Statistics of Precipitation.

Table 6.8. Graduate Students Supported at the Joint Centers

Student	University	Topic	Advisor/Sponsor
Brittany McClure	UMCP	OMI SO ₂ data validation with aircraft <i>in situ</i> data	Russell Dickerson (UMCP) Nickolay Krotkov (613.3, GEST)
Ravi Siddani	UMBC	Space-time Statistics of Precipitation	Prasan Kundu, 613.2

UMBC: University of Maryland, Baltimore County.

UMCP: University of Maryland, College Park.

6.5 Open Lecture Series

Distinguished Lecturer Seminar Series

One aspect of the Laboratory's public outreach is a Distinguished Lecturer Seminar Series, which is held each year and is announced to all our colleagues in the area. Most of the lecturers are from outside NASA and this series gives them a chance to visit with our scientists and discuss the latest ideas from experts. The following were the lectures presented in 2006.

January 26

Robert Adler, NASA GSFC, Laboratory for Atmospheres
Variations in Global Precipitation: Climate-scale to Floods.

February 16

Michael Prather, Jefferson Science Fellow, U.S. Dept. of State, and Kavli Professor, University of California at Irvine
Lifetimes, Time Scales and Feedbacks in Atmospheric Chemistry.

March 16

Andy Heymsfield, National Center for Atmospheric Research, Boulder, Colorado
Ice Cloud Properties from *In Situ* Observations and Application to Spaceborne Active Remote Sensors.

April 20

Paul Newman, NASA GSFC, Atmospheric Chemistry and Dynamics Branch
Recovery of the Antarctic Ozone Hole.

June 15

Greg Tripoli, University of Wisconsin, Madison
Hybrid Spectral Habit Prediction Schemes - A new approach to explicit microphysics prediction.

July 27

Joyce Penner, University of Michigan Department of Atmospheric, Oceanic and Space Sciences
Aerosols and Climate: Can we quantify the effect of aerosols on climate change and does it matter?

August 17

Bruce Albrecht, University of Miami
Cloud-Aerosol-Drizzle Interactions Nature's Way.

October 20

Phil Rasch, National Center for Atmospheric Research
Geo-Engineering Climate Change with Sulfate Aerosols.

6.6 Public Outreach

In addition to teaching and committee work, Laboratory members give seminars to university and other student groups and to public audiences. Among the student groups are those participating in Goddard's Scientific and Engineering Student Internship program (SESI). SESI is a joint program with the Physics Department of the Catholic University of America and the Astrophysics Science Division and Science and Exploration Directorate at GSFC. In addition to their summer research activities students attend a weekly seminar given by a Goddard scientist. Two of these, dated June 21 and June 29, are described in the following list.

January 17

Wei-Kuo Tao (613.1) gave a talk at North Carolina State University entitled "A Coupled GCM-Cloud Resolving Modeling System, and A Regional Scale Model to Study Precipitation Processes."

February 2

Wei-Kuo Tao (613.1) gave a talk entitled "A coupled GCE-Cloud Resolving Modeling System and a Regional Scale Model to Study Precipitation Processes." at The Distinguished Lecturer Seminar Series of the Department of Meteorology, Penn State University.

May 1

Paul Newman (613.3) gave a talk at the Meteorology Department, University of Maryland entitled, "When will the Antarctic ozone hole recover?"

May 23–26

George Huffman (613.1, SSAI) reviewed two student posters and two student presentations as part of the student award process at the 2006 Joint Assembly of the AGU, 23-26 May 2006, Baltimore, MD.

June 5

Wei-Kuo Tao (613.1) gave a talk at National Central University entitled "Using Multi-scale Modeling System to Study the Interactions between Clouds, Precipitation, Aerosols, Radiation and Land Surface."

June 12

Robert Adler (613), Scott Braun (613.1), and David Adamec (614.2) participated in Media Day at NASA GSFC, an event geared toward introducing the media to NASA scientists involved in hurricane related research. Adler presented information on the TRMM satellite and its application to hurricane research (as well as the more general topic of heavy rainfall events). Braun presented highlights of his research on hurricanes, including numerical modeling, field research programs, and applications of TRMM data. Adamec presented a film highlighting last

years active hurricane season and discussed prospects for the coming season. Adler and Adamec were interviewed by the media, with news stories carried on television. Braun was interviewed for an NPR radio story on hurricanes and the sometimes odd methods that scientists suggest for weakening them.

June 21

Steven Platnick (613.2) gave a talk to SESI students. The title was “An Overview of NASA Earth Science Observations: The View from Space.”

June 28

Charles Jackman (613.3) gave a SESI talk titled “Has the Ozone Layer Changed.”

July 20

Scott Braun (613.1) gave a presentation entitled “Monster Storms: NASA Research on Hurricanes.” to two groups of teachers at the JASON Action Summit held in Washington D.C, July 18-20, 2006. The JASON Project is a nonprofit educational organization whose goal is to inspire student learning in science, math, and technology.

August 7

A media event was held at the Howard University Research Campus in Beltsville, MD as a part of the Aura validation effort called WAVES that was being hosted there. The links for several news reports are now posted on the WAVES Web site at <http://ecotronics.com/lidar-misc/WAVES.htm> under the link called “WAVES in the news”. David Whiteman (613.1) and Belay Demoz (613.1) are the NASA leads of this satellite validation activity.

August 21 (Summer Visitors:)

David Bolvin (613.1, SSAI) served on the review panel on August 18, 2006 for two H.I.P Summer Intern presentations:

- (1) “Rocks That Deliver Electric Currents: Activation by Stress” by Gerasimos Michalitsianos
- (2) “Multifractal Properties of Time-Averaged Rainfall Data” by Mael Flament

September 5

Eyal Amitai (613.1, GMU) organized a 3-day training program on space-borne and ground-based radars for visitors from the Met. Service of Cyprus. The visit was sponsored by America-Mideast Educational & Training Services, Inc.

September 21

Scott Braun (613.1) gave two talks on Thursday, Sept. 21 on “Hurricane Research at Goddard”. The first presentation was made to Dr. Charles Kennel, former member of the NASA Advisory Council, during his visit to Goddard. The second presentation was to graduate students participating in the Graduate Student Researchers Program Symposium being held Sept. 20-22 at Goddard.

September 25

Anne Douglass (613.3) was the 2006 Morris Katz Memorial Lecturer on Environmental Research at York University in Toronto, Canada. Her talk was entitled, “Discoveries from EOS Aura.” The audience included faculty, students, members of Dr. Katz’s family, and was open to the general public. She was the 16th lecturer

and the first woman in this series and was given a commemorative plaque. A second copy of the plaque will be displayed at the university.

October 19

Clark Weaver (613.3,GEST) gave a talk on global warming to the 9th grade science class at the Washington International School, Washington, DC.

October 23

George Huffman (613.1,SSAI) gave a presentation to the Asia Pacific Satellite Training Seminar (APSATS), Melbourne, Australia. APSATS was a 2-week training event sponsored by the World Meteorological Organization for about 30 personnel from national meteorological services in the Asia-Pacific region. The title was ‘Where to Find Precipitation Products, Including TOVAS’ (TRMM Online Visualization and Analysis System).

October 31

Paul Newman (613.3) spoke about the 2006 Antarctic ozone hole with approximately 60 science writers.

November 2

Paul Newman (613.3) gave a talk at Penn State University entitled, “When will the Antarctic Ozone Hole Recover”?

November 11

George Huffman (613.1, SSAI) Thunderstorms 101. Presentation to United Methodist Men, St. Matthews United Methodist Church of Bowie, MD. This was a Public lecture for about 20 attendees.

November 27

Wei-Kuo Tao (613.1) gave a talk at University of Maryland entitled “Using Multi-scale Modeling System to Study the Interactions between Clouds, Precipitation, Aerosols, Radiation, and Land Surface”.

December 4

Scott Braun (613.1) gave a talk to meteorology students at San Francisco State University on Dec. 7 entitled “Peering into the hurricane intensity problem using NASA satellites, aircraft, and models”.

Undated

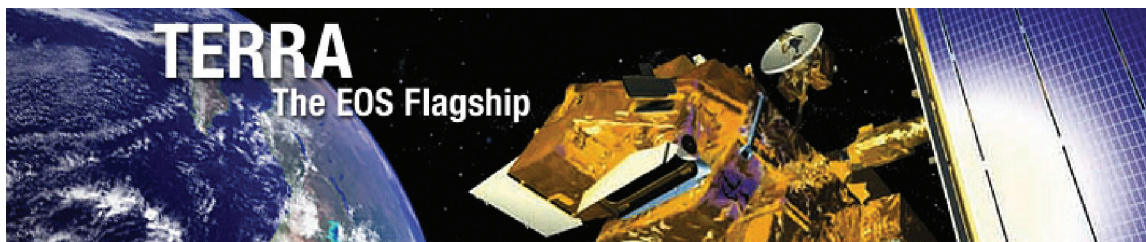
George Huffman (613.1, SSAI) served as a resource for the NASA/EOS Earth Observatory Web site’s Ask A Scientist dept., writing 4 responses to questions in 2006.

Matthew Deland (613.3, SSAI) was named as a research principal investigator in an education and public outreach proposal titled “Exploring the Sun-Climate Connection through Student Observations”. The team lead is Robert Cahalan (613.2).

6.7 Project Outreach

Funded projects in which Laboratory members participate contain elements of both education and public outreach that are described on the project Web sites. Some of these outreach efforts are summarized in the following sections.

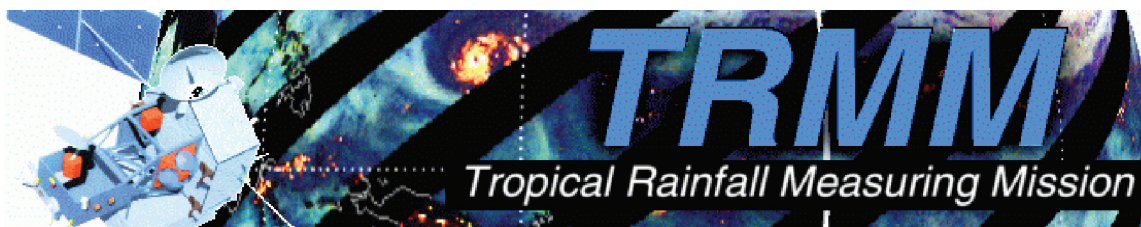
TERRA



The EOS Terra outreach effort is a coordinated effort to foster greater cooperation and synergy among the various outreach groups within the EOS community. The Terra mission is designed to improve understanding of the movements of carbon and energy throughout Earth's climate system.

The "About Terra" link on the Terra home page (<http://terra.nasa.gov>) contains links to five tutorials designed to inform the public about the importance of the physical parameters observed by the instruments aboard the Terra spacecraft. These tutorials deal with the properties of aerosols, changes in cloud cover and land surface, the Earth's energy balance, and the role of the oceans in climate change. The home page also contains 14 direct links to topics maintained by the Earth Observatory, an outreach site of the Committee for Education and Public Outreach. These links discuss a wide range of topics including Antarctica, flood plains, glaciers, air pollution, and volcanoes discussing each in the context of Terra observations and why such observations are important. The Terra Web site also contains a number of links under 'Features' to tutorials on topics of interest such as hurricanes and the cost of natural hazards. These tutorials are part of the NASA Earth Observatory Web site.

TRMM



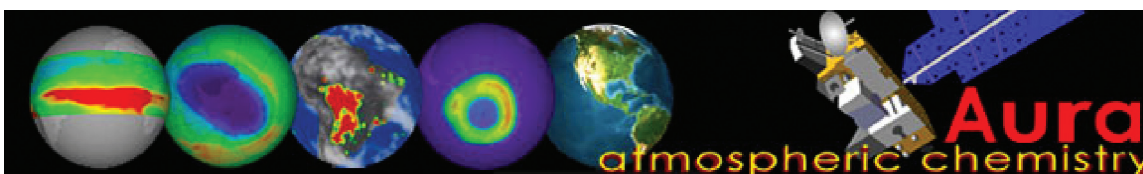
TRMM is a joint mission between NASA and the Japan Aerospace Exploration Agency (JAXA) designed to monitor and study tropical rainfall. TRMM continues its comprehensive Education/Outreach program, in which Laboratory personnel promote TRMM science and technology to the public under the leadership of TRMM Project Scientist Robert Adler (Code 613), and TRMM Education and Outreach Scientist Jeffrey Halverson (613.1, JCET). TRMM has also included the development of broadcast visuals and educational curriculum in its outreach activities. The Educational Resources link on the TRMM home page leads to five problem-based classroom modules in PDF format. These manuals are titled "Investigating the Climate System" and consist of tutorials on clouds, winds, precipitation, weather, and energy. The first four are appropriate for students in grades 5–8, the last is directed at students in grades 9–12. These packages are available on the TRMM Web site (<http://trmm.gsfc.nasa.gov/>) and have been reviewed as a part of the Earth Science Enterprise (ESE) Education product review. There are also 11 educational videos that give brief tutorials on various aspects of the TRMM project and on the atmosphere's water and energy cycles.

Global Precipitation Measurement (GPM)



The GPM is a follow-on and expanded mission of the current ongoing TRMM. GPM is one of the Earth Observation Satellite programs, mainly initiated by JAXA, the National Institute of Information and Communications Technology (NICT) and NASA. Both the 'Science' and 'Public Outreach' links on the GPM Web site (<http://gpm.gsfc.nasa.gov/index.html>) contain a wealth of educational materials. The Science page begins with a tutorial, 'The Science of Measuring Precipitation: Why It Matters' that is followed by links to seven additional discussions of the satellite, its instruments, and what will be measured.

EOS Aura



The Aura satellite was launched from Vandenberg AFB on July 15, 2004. The Laboratory for Atmospheres has responsibility for conducting the Education and Public Outreach program for the EOS Aura mission. Aura's Education and Public Outreach program has four objectives:

- (1) Educate students about the role of atmospheric chemistry in geophysics and the biosphere;
- (2) Enlighten the public about atmospheric chemistry and its relevance to the environment and their lives;
- (3) Inform geophysics investigators of Aura science, and thus enable interdisciplinary research; and
- (4) Inform industry and environmental agencies of the ways Aura data will benefit the economy and contribute to answering critical policy questions regarding ozone depletion, climate change, and air quality.

To attain these objectives, the Aura project supports a strong educational and public outreach effort through formal and informal education partnerships with organizations that are leaders in science education and communication. Partners include the Smithsonian Institution's National Museum of Natural History (NMNH), the American Chemical Society (ACS), and the Global Learning and Observations to Benefit the Environment (GLOBE) Program. Our goals are to educate students and the public and inform industry and policy makers how Aura will lead to a better understanding of the global environment.

NMNH, working with Aura scientists, will design and create an interactive exhibit on atmospheric chemistry as part of its Forces of Change program. NMNH will convey the role that atmospheric chemistry plays in people's lives through the use of remote sensing visualizations and museum objects.

The ACS has produced special issues of the publication ChemMatters. These issues will focus on the chemistry of the atmosphere and various aspects of the EOS Aura mission. The special editions of ChemMatters will reach approximately 30,000 U.S. high school chemistry teachers and their students.

The Globe Program is a worldwide network of students, teachers (10,000 schools in over 95 countries), and scientists working together to study and understand the global environment. Drexel University's (Philadelphia,

Pennsylvania) ground-based instruments will measure ultraviolet-A (UV-A) radiation and aerosols to support measurements taken from the Aura spacecraft. A tropospheric ozone measurement developed by Langley Research Center is also a GLOBE protocol.

Aura's Education and Project Outreach program will also be present at science and environmental fairs and science and technology conferences to demonstrate how Aura fits into NASA's program to study the Earth's environment. The Aura Web site is <http://aura.gsfc.nasa.gov/>.

TOMS



The Atmospheric Chemistry and Dynamics Branch is committed to quality scientific education for students of all ages and levels. The TOMS Web site contains resource materials for science educators at <http://toms.gsfc.nasa.gov/teacher/teacher.html>. Three lessons that make use of TOMS data and that study the uses of Earth-orbiting satellites are presented at this site. One of these is directed at students in grades 5–8, others are directed to those in grades 9–12. There is also a link to five projects for independent research, which allow advanced students to learn more about atmospheric chemistry and dynamics.

There is also an online textbook at http://www.ccpo.odu.edu/SEES/ozone/oz_class.htm written by Branch scientists and was designed as an educational resource for the general public, as well as for students and educators. This book contains 12 chapters covering all aspects of the science of stratospheric ozone. Each chapter has numerous low- and high-resolution figures, and ends with a set of review questions.

A TOMS Engineering Model is part of a permanent exhibit entitled “Change is in the Air” at the Smithsonian’s NMNH. This exhibit explores the interactions between atmospheric chemistry and climate, emphasizing ozone trends in the stratosphere and the effects of degrading air quality on the environment. The TOMS Engineering Model was on exhibit from April through November of 2006.